(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(54) Title: DYNAMIC DSCP AVAILABILITY REQUEST METHOD
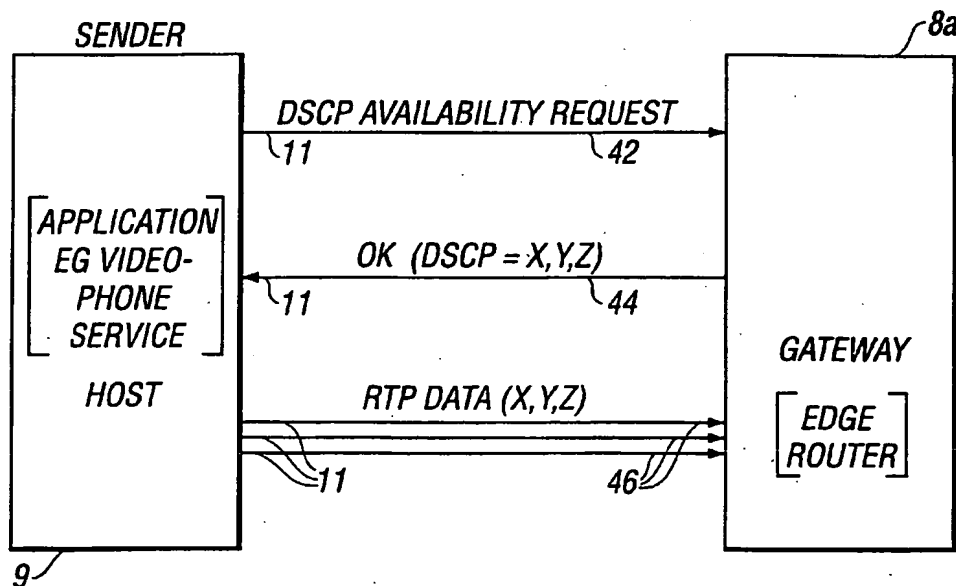
(57) Abstract: A communications interface between an end-user and an edge node of a communication network for establishing, prior to data transmission, the differentiated service code points supported by the network. The end-user first issues a service request message (42) to an edge node of the communication network. The edge node responds with an acknowledgment message (44) carrying information as to which DSCP's the network is able to support. Finally, the application at the end-user can decide how to mark the relevant packets during data transmission depending on the levels of differentiated service supported by the network.

DYNAMIC DSCP AVAILABILITY REQUEST METHOD

The present invention relates to the transmission of messages across different differentiated service communication networks.

The boundaries between the various 'traditional' networks are becoming increasingly blurred. Nowadays, there is a significant overlap between applications traditionally in the telecommunications domain, i.e. circuit-switched traffic (voice) and applications traditionally in the data communication domain, i.e. packet-switched traffic (data).

The two basic approaches to packet-switching are well known:

i) "Connection-oriented" technique where during an initial phase a 'virtual circuit' is first established between two end-users (analogous to a standard voice circuit) and then packet data is transmitted down this pipe. An example is the X.25 network commonly used for public packet data networks.

ii) "Connection-less" technique also known as datagram switching or a "best-effort network". An example of this approach is the Internet, which uses a datagram service where at each node (or router) the IP packet header is examined and the packet is routed to another intermediate node that is closer to the recipient. Thus, the packets are routed on a 'hop-by-hop' basis.

One of the differences between these two approaches is that the packet structure of the "connection-oriented" approach can use short headers, because the path of the envisaged data stream (virtual circuit) has already been established. In contrast, the data packets for the connection-less approach can arrive at the receiver in any order and each packet is treated as a 'self-contained' entity and therefore the header needs to carry full information about the intended recipient.

The unprecedented growth of the Internet has meant that network operators and service providers ISP's need to try and offer adaptable networks, which are

flexible in allowing a variety of traffic including not only 'traditional' data traffic but also voice traffic (such as VoIP), data packet applications of a 'bursty' nature and emerging multimedia applications which include bandwidth, latency and jitter requirements.

The subject area concerned with the development of the various network architectures is constantly evolving to allow for possible future network expansion and/or more efficient implementation technologies. The IETF (Internet Engineering Task Force) attempts to standardise and coordinate working groups in emergent areas of Internet technology. One of these groups is the Differentiated Services work group (DiffServ). However, due to the advancements in this area, much of the techniques associated with Differentiated Services are still under development. Differentiated service mechanisms allow providers to allocate different levels of service to different users of the Internet, while accommodating heterogeneous application requirements.

QoS (Quality of Service) is an important set of parameters, which provide indication as to the quality of the service that can be expected from the network at a certain time. More generally, QoS is concerned with the measurement and improvement of transmission rates, error rates and trying to guarantee a certain level of transmission in advance. One of the major factors that influence the QoS is the amount of traffic on a communication network at any instant in time. The busier the network, the harder it will be for a 'bandwidth-intensive' application to obtain the required resources so that the transmission is of an acceptable quality. Certain applications (for example videophone) need to know the QoS to determine whether or not the service can be fully supported.

Differentiated Services will be referred to herein as "DiffServ". It should also be noted that the terms 'node' and 'router' may be used interchangeably in this description, because the specific example provided is the Internet where routers are used to switch data traffic.

Various technologies including DiffServ and RSVP (Resource Reservation Protocol) have been suggested to allow for so-called 'QoS-aware' data transfer, especially in multimedia applications (such as videophone) that place high bandwidth demands on the network. The known solutions each have limitations, which the present invention attempts to overcome.

Many modern "bandwidth-intensive" applications require a certain QoS to be certain that the application will be supported across the network. The Resource Reservation Protocol (RSVP) allows a host device to request a specific QoS from the network, on behalf of the application. To do this, the RSVP makes resource reservations for each node in the network that carries a particular application's data stream. Each node determines whether there are sufficient resources (i.e. bandwidth) to provide the required QoS value. The main drawbacks of RSVP are that this technique is complex, requires a lot of overhead processing in every hop and does not scale well. It is evident that the greater the number of nodes in a network, the more RSVP signalling will be required to determine whether a certain QoS can be sustained.

The Differentiated Services architecture is also 'QoS aware', however whereas RSVP incurs large overhead in negotiating sufficient resources from each node of an envisaged data path, no signalling between nodes is required for DiffServ. Instead edge routers, within a DiffServ-capable network, 'mark' the header of each IP (Internet Protocol) packet making up a particular applications data stream with a certain priority value known as a code point. The intermediate nodes then identify the code point field, which is translated into a particular PHB (Per Hop Behaviour) and the packet is forwarded accordingly. The advantage of such a scheme is that the processing and associated storage circuitry for each intermediate router is considerably simplified since QoS is invoked on a per-packet basis. However, the present state of the Differentiated Services architecture, herein referred to as "basic DiffServ", also has inherent problems.

The per-packet code point values are set by the sending application. Therefore, basic DiffServ does not guarantee resources and the recipient is limited in controlling the QoS of the received data stream. Also, before transmitting the data stream the sender does not know which DSCP's (Differential Service Code points) are supported.

It is an aim of the present invention to overcome or at least mitigate these problems.

The present invention provides in one aspect a method of transmitting data in a communications system to take into account networks capable of supporting different service levels, , wherein i) a service request message is sent to a network across which the data is to be transmitted; ii) a response message is issued from the network identifying the service levels supported by the network; iii) the data is marked with a service identifier identifying a service level selected from the service levels supported by said network; and iv) said marked data is transmitted across the network in accordance with the identified service level.

Preferably, the network comprises a plurality of nodes, at each of which the service identifier of a received data is examined and translated into a forwarding behaviour. In one embodiment the data is Internet Protocol (IP) packets, and the service identifier is in the form of a Differentiated Services code point (DSCP).

Also, in the described embodiment, each data packet has a packet header and said code point is located in an 8-bit field in bit positions 8 to 15 of said packet header. The response message returns the service levels in the form of a list of DiffServ code points.

The present invention also provides data transmission circuitry for transmitting data over a communications network said data transmission circuitry comprising: means for issuing a service request message to said communications network;

and means for selecting from a list of returned service identifiers a class of service for transmitting a message and marking data of that message with the selected service identifier.

The present invention also provides data receiving circuitry forming part of a communications network capable of supporting different classes of service for transmitting messages, said data receiving circuitry comprising: a store holding a list of service identifiers corresponding to classes of service capable of being supported by said communications network; and means for formulating a response message in response to receiving a service request message from the user to acknowledge said request, said response message containing the list of service identifiers.

The present invention will now be described by way of an example with reference to the accompanying drawings, in which:-

Figure 1 shows a generic network model of end-users being connected through an intermediate network;

Figure 2 shows an example of how packets of a videophone application may be routed through the Internet from a sender to a receiver;

Figure 3 shows the basic structure of a data packet;

Figure 4 shows an IPv4 (Internet Protocol version 4) packet header;

Figure 5 shows an enlarged view of the DS (Differential Services) field;

Figure 6 shows the interface signals between the sending application and the DSCP gateway; and

Figure 7 shows a BB (Bandwidth Broker) system.

The embodiment described below discusses a DiffServ network that overcomes the scaleability issues of an RSVP network, while improving the existing DiffServ architecture by providing the end-users with a means of establishing the capability of the network before data transfer.

Figure 1 shows a general network cloud 4 that allows two end-users, i.e. USER A 2 and USER B 6 to communicate. There are various types of networks and protocols that may be applied to this generic model. For example, the network 4 might be any of the following: PSTN (Public Switched Telecommunication Network), PLMN (Public Land Mobile Network), Internet, Intranet, X.25, LAN (Local Area Network), WAN (Wide Area Network), etc. and the protocols might be even more numerous.

Figure 2 shows an example where the network 4 is the Internet. It will be assumed that a videophone service needs to be provided between a sender 9 and a recipient 10 over the Internet 4. Data packets that make up the video stream will be switched through the Internet from the sender 9 to the recipient 10 using the IP (Internet Protocol) and routers R labelled 8a, 8b, 8c and 16 to route the data packets.

A number of elements that are important to the DiffServ architecture need to be defined. There are 'edge' or 'leaf' nodes (routers) 8a, 8b, 8c located at the borders of a network and either connect to an end-user via end-user connections 11 or to another network 5 via a network connection 15. Intermediate nodes (routers) 16 occupy the 'heart' of the network and packets are passed to or from other intermediate nodes 16 or edge nodes 8a,8b,8c.

Figure 3 shows the basic structure of a data packet comprising a header portion 20 and a data portion 22. Two versions of the Internet Protocol (IP) are specified for DiffServ, i.e. either version 4 or version 6. Both versions include a header having a number of fields. In particular, the IPv4 header includes a 'TOS' (Type of Service) and the IPv6 header includes a 'Traffic Class' field. The main idea behind DiffServ is to modify the 'TOS (type of Service)' field in the header of an IPv4 packet, or the 'Traffic Class' field in the header of an IPv6 packet, to become a DS byte field known as the DS field.

Figure 4 shows the structure of the header for an IP packet in IPv4. It can be seen that the header consists of five 32-bit words W1-W5, where bits 8-15 of the first word W1 are used for the Type of Service (TOS) octet 26. Figure 5 shows the modified octet 26', which consists of a 6-bit DS field 28 used to mark the packet with a certain DSCP (Differential Services Code Point). The two remaining bits 29 are currently unused (CU).

Each packet receives a particular forwarding treatment at each node based on the marked bit pattern which defines the DSCP's. That is, each node of the network contains a mapping table for translating each DSCP field into a specific per-hop behaviour (PHB). As is known, the PHB for a packet is the forwarding behaviour it receives at a given network node, for example "best effort" or "normal". Therefore, a network node inspects each received data packet and ascertains from the DSCP what the class or the priority of the packet is and how it should be forwarded. The bit patterns defining the code points (DSCP's) have been standardised to some degree by the IETF's DiffServ working group. A number of code points are shown in Annexe 1 taken from RFC (Request For Comments) 2474.

The 8-bit DS field 26' is capable of conveying 64 distinct code points. From Annex 1, it can be seen that the code point space is divided into three pools where 'x' refers to either '0' or '1':

- Pool 1 containing 32 code points that have been provisionally assigned as indicated.

- Pool 2 containing 16 code points (Pool 2) to be reserved for experimental or Local Use, and

- Pool 3 containing 16 code points, which are initially available for experimental or local use, but would be used for any other standardised assignments if Pool 1 is ever exhausted.

It can be seen that pool 1 has 1 EF (Expedited Forwarding) code point, 12 AF (Assured Forwarding) code points and several local use code points (CS0-7). Furthermore, the 12 AF code points consists of four AF 'classes' where each class has three code points representing levels of priority known as 'drop precedences'. For example, AF class 1 is composed of three drop precedences, i.e. AF11, AF12 and AF13.

To use DiffServ, code points (DSCP's) are assigned at the edge nodes 8a, 8b, 8c of the network. In figure 2, the videophone service (sender 9) is aware of the QoS needed to support it and marks the DS field 26' in the packets it transmits with the required code point. The edge routers 8a, 8b, 8c would also contain traffic conditioning entities such as: meters, markers, droppers, and shapers that could re-mark a traffic stream or may discard or shape packets to comply with a desired traffic profile.

In so-called basic DiffServ there is a danger that certain nodes of the intermediate network may not be able to support the selected DSCP in the packet. In that case, the node will remark the DSFIELD accordingly. The result may be a poor quality transmission or the video stream may be dropped altogether.

The described embodiment of the invention avoids this as described below. Figure 6 shows the interface 11 between the sender 9 and the gateway to the network 4. The gateway is the edge router 8a attached to the sender 9. The interface 11 may be implemented by slight modifications to various existing signalling protocols including SIP, RTCP, Cops, SNMP, HTTP or a new 'lightweight' protocol may be developed, for example an ASCII-based request/response protocol.

The following sequence of events are executed prior to actual data transmission of the video stream. A sending application at the sender 9 wishes to transmit a video data stream for a videophone application through the network 4 to the

receiver 12. Firstly, the sender 9 issues a *DSCP AVAILABILITY REQUEST* message 42 addressed to the gateway 8a. The gateway 8a holds a list of the available DSCP's that the network can support. The gateway may also contain a user profile where only certain users may have access to certain DSCP's. This can be done on a cost basis, i.e. for a 'premium' class of service a higher DSCP will be made available at increased cost. The concept of 'user profiling' and 'policies' are well known and beyond the scope of the present invention. Next, the gateway 8a responds with an OK message 44 to the sender 9 acknowledging the request message and carrying additional information that defines all the available DSCP's available to the application at the sender 9. If, for example the message is:

> *OK (X, Y, Z)*

this informs the sending application at the sender 9 that classes X, Y and Z are available. The sending application is then able to start transmitting the RTP (Real Time Protocol) data streams 46 using DSCP's X, Y or Z, selected on a per-packet basis by the sending application.

By requesting the supported DSCP's before data transmission, the sending application is able to act accordingly and classify packets based on this information thus improving the perceived quality of the IP video stream. In many applications, particularly video, packets have different importance. The classification of these packets can be made very efficient if the sending application knows in advance, which DSCP's are supported by the network.

It is also possible that the list of supported DSCP's is changed in the gateway 8a. If so, the gateway 8a informs end-users about the change by using local multicasting, where the list of supported DSCP's is transmitted to all registered end-users at the same time or alternatively by direct unicasting where the list is only supplied to a single specified end-user address at any given time. It is beneficial for a network operator that end-users (customers) are dynamically updated about the supported DiffServ classes so that precious network resources

are not wasted in trying to provision a particular service that cannot be supported for whatever reason.

The present invention is interoperable with existing systems. Furthermore, important issues such as security and reliability are easily implemented. As with other signalling protocols, for example HTTP (Hyper Text Transfer Protocol) or SIP (Session Initiation Protocol), authentication of users or sending applications is made possible using known techniques, for example using public keys. If the sending party's request 42 is not acknowledged reliability can be achieved by re-transmissions. The sending party might use a simple time-out algorithm, where if a response is not received from a gateway within a predefined period, the DSCP AVAILIBILITY REQUEST message 42 will be re-transmitted.

It has already been described that the present invention will be interoperable with existing Diffserv technologies. Therefore, concepts such as an RTP (Real Time Protocol) QoS Manager or a BB (Bandwidth Broker), introduced as part of the Differential Services architecture would still apply. The RTP QoS Manager is an object that may reside within or outside the sending application of the sender 9 and whose purpose is manage and organise the packets particularly for multimedia traffic streams having real-time constraints. The BB is a functional entity used at a higher level in dealing with the control or resource management both within a DiffServ-capable network (i.e. intra-domain resource management) and between a plurality of DiffServ-capable networks (i.e. inter-domain resource management).

Figure 7 represents a typical BB system with a client/server relationship, where collaborating network operators or customers may use a client terminal to enter various parameters relating to SLA (Service Level Agreements) and/or BAR (Bandwidth Allocation Requests), which have previously been established. DiffServ boundary nodes may act as both a DiffServ 'ingress node' and/or an 'egress node' depending on the direction of traffic. Traffic enters at a Diffserv-capable network at a DS ingress node and leaves at a DS egress node.

Therefore, in figure 2 the node 8c is an egress router, which is the edge router responsible for transmitting the video stream packets to the second network 5. The BB server is able to communicate with edge routers to set up their corresponding traffic conditioning elements.

Referring back to figure 2 it can be seen that in certain situations a data stream may 'cross' networks in trying to reach a final destination. For example, consider the case when the sending application at the sender 9 connected to a first network 4 wishes to transmit a video stream to a receiver 14 connected to a second network 5. Although, the sender 9 may have communicated with the first network over interface 11 where it was established which DSCP's are available in network 4, the sender 9 cannot be certain that the same DSCP's are supported in the second network 5.

This problem may be solved by the BB, which could make a similar *DSCP AVAILABILITY REQUEST* message to the edge router 8d of network 5. The *OK* response contains a list of supported DSCP's in the second network 5, which the BB could forward back to the sender. The sender now has knowledge of which DSCP's are available in both networks. If the first network supports classes X, Y and Z, while the second network only supports classes X and Z, then the sending party knows that the video stream packets should only be marked with the DSCP's X and Z. If the sender 9 decides that the video stream to be transmitted needs to have the data packets marked with at least three DSCP's (X, Y and Z) to be adequately supported, then the video stream service will not be transmitted to the recipient 14, until the second network supports the Y class.

The implementation of an 'inter-domain availability method' is possible as the BB in basic Diffserv describes the edge routers of DiffServ-capable networks each having an interface with the BB so that inter-domain resource management functions such as SLA's (Service Level Agreements) and BAR (Bandwidth Allocation Requests) may be performed, as shown in figure 9. It will be appreciated as described above that the BB element is at a higher level than the

routing network and as such the links 60, 62 and 64 are not the same as the links 17 of figure 2.

It should be realised that the BB is provided as an example of how the present invention may be incorporated into an element of the DiffServ architecture and is intended to be non-limiting. It would be appreciated by a man skilled in the art that the present invention may be adapted to other DiffServ elements equally well.

Annexe 1.

Pool	Codepoint space	Assignment Policy	Reference
1	xxxxx0	Standards Action	[RFC2474]
2	xxxx11	EXP/LU	[RFC2474]
3	xxxx01	EXP/LU (*)	[RFC2474]

Pool 1 Code points (Guidelines from RFC2474)

Name	Space	Reference
CS0	000000	[RFC2474]
CS1	001000	[RFC2474]
CS2	010000	[RFC2474]
CS3	011000	[RFC2474]
CS4	100000	[RFC2474]
CS5	101000	[RFC2474]
CS6	110000	[RFC2474]
CS7	111000	[RFC2474]
AF11	001010	[RFC2597]
AF12	001100	[RFC2597]
AF13	001110	[RFC2597]
AF21	010010	[RFC2597]
AF22	010100	[RFC2597]
AF23	010110	[RFC2597]
AF31	001110	[RFC2597]
AF32	011100	[RFC2597]
AF33	011110	[RFC2597]
AF41	100010	[RFC2597]
AF42	100100	[RFC2597]
AF43	100110	[RFC2597]
EF PHB	101110	[RFC2598]

CLAIMS

1. A method of transmitting data in a communications system to take into account networks capable of supporting different service levels, wherein:

        i)   a service request message is sent to a network across which the data is to be transmitted;

        ii)   a response message is issued from the network identifying the service levels supported by the network;

        iii)   the data is marked with a service identifier identifying a service level selected from the service levels supported by said network; and

        iv)   said marked data is transmitted across the network in accordance with the identified service level.

2. A method according to claim 1, wherein the network comprises a plurality of nodes, at each of which the service identifier of a received data is examined and translated into a forwarding behaviour.

3. A method according to any preceding claim wherein the data is Internet Protocol (IP) packets, and the service identifier is in the form of a Differentiated Services code point (DSCP).

4. A method according to claim 3, wherein each data packet has a packet header and wherein said code point is located in an 8-bit field in bit positions 8 to 15 of said packet header.

5. A method according to any preceding claim, wherein said response message returns the service levels in the form of a list of Differentiated Services code points.

6. Data transmission circuitry for transmitting data over a communications network said data transmission circuitry comprising:

means for issuing a service request message to said communications network; and

means for selecting from a list of returned service identifiers at least one class of service for transmitting a message and marking data of that message with the selected service identifier.

7. Data receiving circuitry forming part of a communications network capable of supporting different service levels for transmitting messages, said data receiving circuitry comprising:

a store holding a list of service identifiers corresponding to classes of service capable of being supported by said communications network; and

means for formulating a response message in response to receiving a service request message from the user to acknowledge said request, said response message containing the list of service identifiers.
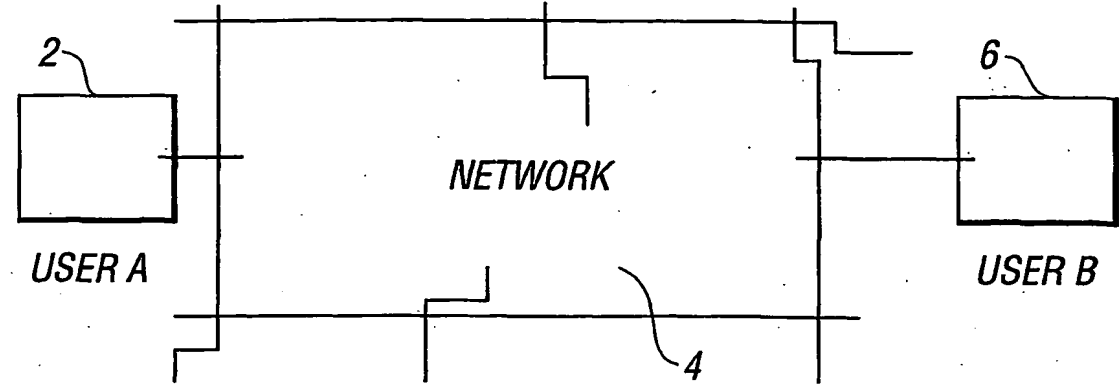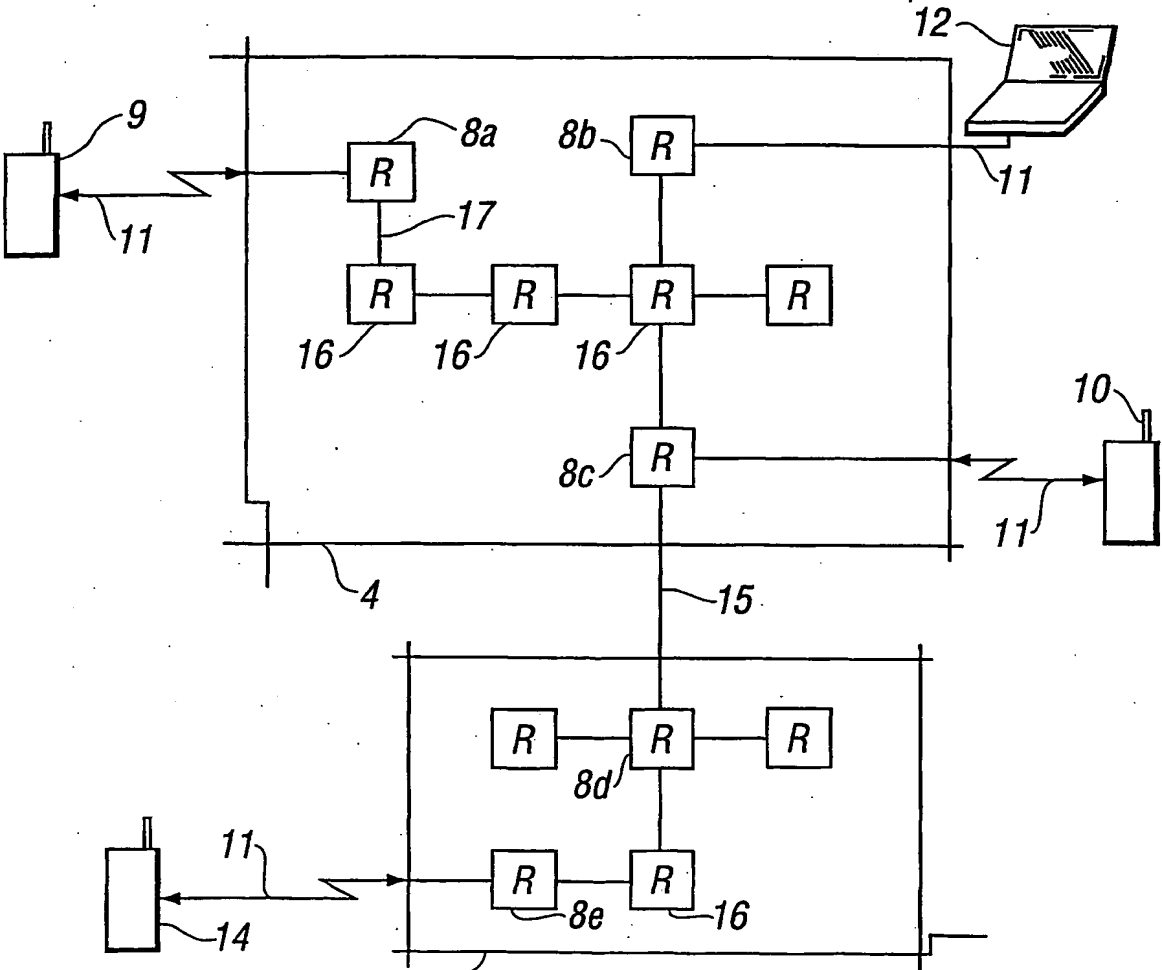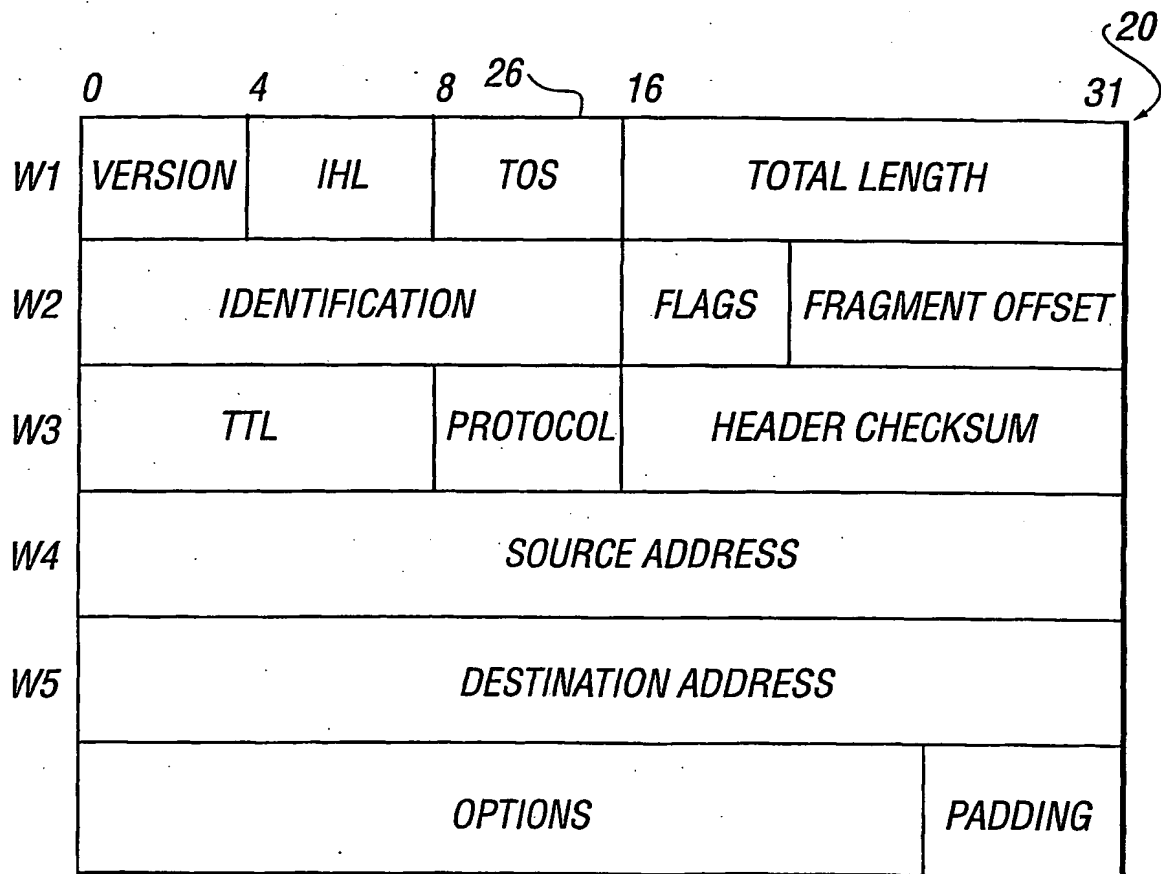
FIG. 1

FIG. 2

HEADER	DATA

20

FIG. 3

20

	0	4	8	26	16	31

W1	VERSION	IHL	TOS	TOTAL LENGTH
W2	IDENTIFICATION		FLAGS	FRAGMENT OFFSET
W3	TTL	PROTOCOL	HEADER CHECKSUM
W4	SOURCE ADDRESS
W5	DESTINATION ADDRESS
	OPTIONS	PADDING

FIG. 4

26'   30

DS FIELD	CU

28   29

FIG. 5

SENDER

DSCP AVAILABILITY REQUEST

11   42

APPLICATION
EG VIDEO-
PHONE
SERVICE

OK (DSCP = X,Y,Z)

11   44

HOST

RTP DATA (X,Y,Z)

11   46

9

8a

GATEWAY

EDGE
ROUTER

FIG. 6

CLIENT

BB SERVER

LEAF
ROUTER

BAR

BAR

62

60

64
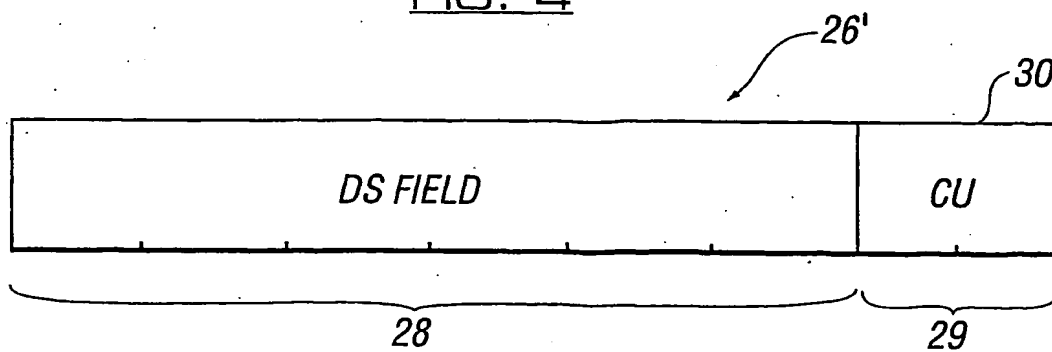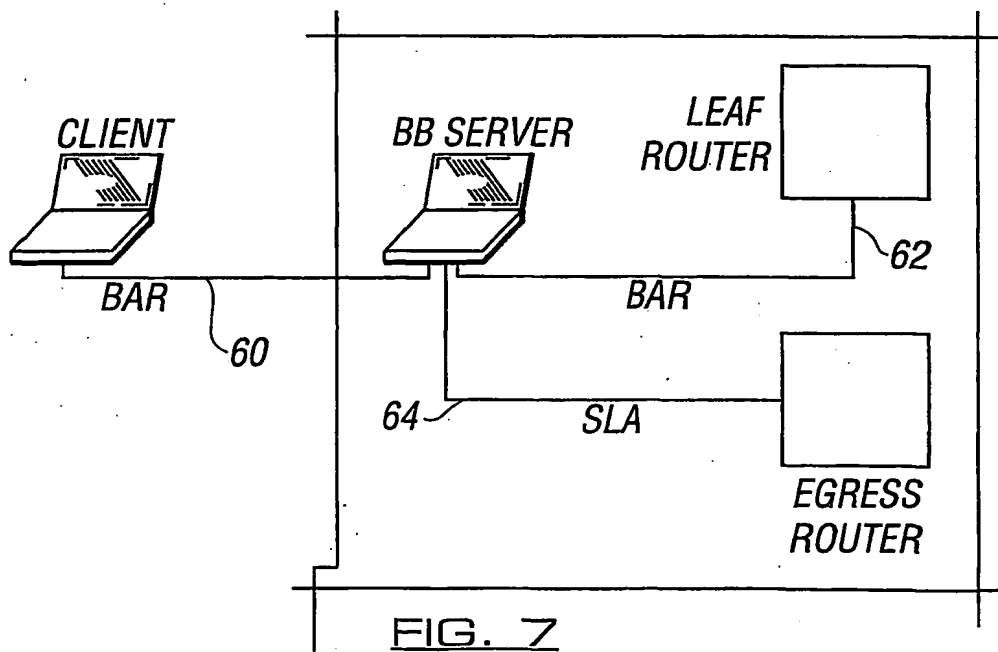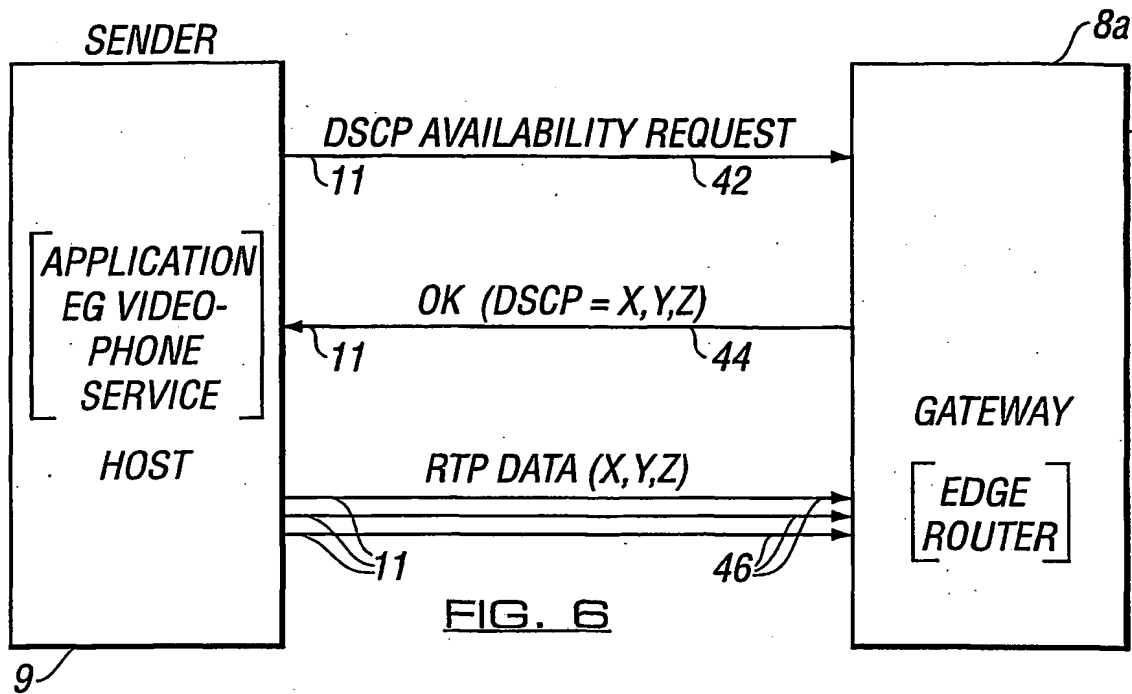
SLA

EGRESS
ROUTER

FIG. 7

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   H04L12/56   H04L29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7   H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, COMPENDEX, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00 30295 A (NORTEL NETWORKS CORP ;CHEN SHENZE (US); FIGUEIRA NORIVAL R (US)) 25 May 2000 (2000-05-25) page 3, line 11-24 page 10, line 13 -page 12, line 3 page 15, line 21 -page 18, line 2	1-4,6,7
X	GB 2 331 659 A (ERICSSON TELEFON AB L M) 26 May 1999 (1999-05-26) abstract; figures 2,3 page 4, line 32 -page 5, line 21 page 6, line 35 -page 7, line 1 page 7, line 27,28 page 14, line 15-18	1,6,7

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[X] Further documents are listed in the continuation of box C.   [X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 August 2001	22/08/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Grimaldo, M

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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X	BERNET Y: "THE COMPLEMENTARY ROLES OF RSVP AND DIFFERENTIATED SERVICES IN THE FULL-SERVICE QOS NETWORK" IEEE COMMUNICATIONS MAGAZINE, IEEE SERVICE CENTER. PISCATAWAY, N.J, US, vol. 38, no. 2, February 2000 (2000-02), pages 154-162, XP000912325 ISSN: 0163-6804 page 156, left-hand column, line 41 -page 157, left-hand column, line 33 page 158, right-hand column, line 26 -page 159, right-hand column, line 45 page 159, right-hand column, line 67 -page 160, left-hand column, line 22 page 160, left-hand column, line 28 -right-hand column, line 51 page 162, right-hand column, line 19-21	1-4,6,7
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A	BAUMGARTNER F ET AL: "Differentiated services: a new approach for quality of service in the Internet" INTERNATIONAL CONFERENCE ON HIGH PERFORMANCE NETWORKING, XX, XX, 21 September 1998 (1998-09-21), pages 255-273, XP002159615 page 4, line 1 -page 5, line 18 page 15, line 27 -page 16, line 27	1-4,6,7

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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